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HOGAN & HARTSON
L.L.P.

DAVID L. SIERADZKI
COUNSEL
DIRECT DIAL (202) 637-6462
INTERNET DS0@DC2.HHLAW.COM

COLUMBIA SQUARE
555 THIRTEENTH STREET, NW
WASHINGTON, DC 20004-1109
TEL (202) 637-5600
FAX (202) 637-5910

January 26, 1999

Magalie Roman Salas
Secretary
Federal Communications Commission
445 Twelfth St., S.W.
Washington, D.C. 20554

Re: Federal-State Joint Board on Universal Service, CC Docket No. 96-45 – *Ex Parte* Filing

Dear Ms. Salas:

I am writing on behalf of Western Wireless Corporation to transmit, as an *ex parte* filing in the proceeding referred to above, the Wireless Cost Model ("WCM"), prepared on behalf of Western Wireless by HAI Consulting, Inc. ("HAI"). Specifically, I am enclosing: (1) CD-ROM disks including full copies of the model (which can be installed on a personal computer using a Windows 95-compatible operating system by running the program HWM40install.EXE on the disk); (2) a copy of a filing we submitted in August 1998 generally describing the model; and (3) a detailed description of the model provided by HAI.

The WCM estimates the forward-looking economic cost of providing universal service over wireless networks in each ILEC wire center area. Western Wireless believes that the WCM may help the Commission implement its sound conclusion that "to the extent practical, the selected mechanism should estimate the cost of providing the supported services using wireless technology in areas where wireless technology is likely to be the least-cost, most efficient technology." 1/ As such, the WCM could be integrated into the forward-looking economic cost model platform that the Commission recently adopted to estimate forward-looking costs

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1/ *Federal-State Joint Board on Universal Service, Forward-Looking Mechanism for High Cost Support for Non-Rural LECs*, CC Docket Nos. 96-45 & 97-160, Further Notice of Proposed Rulemaking, 12 FCC Rcd 18514, 18555, ¶ 99 (1997).

based on the most cost-effective technology of providing universal service (the "Hybrid Cost Proxy Model" or "HCPM"). 2/

Specifically, we believe that the WCM could be adapted for use as a wireless loop "module" that could be used in connection with the HCPM. This would make it possible to compare the forward-looking cost of service using a wireless network in a particular "wire center" geographic area with the cost using a wireline network, and to select the most efficient, lowest cost technology. 3/

Please contact me if you have any questions.

Respectfully submitted,

David Sieradzki

David L. Sieradzki
Counsel for Western Wireless Corp.

Enclosures

cc: Attached service list

2/ *Federal-State Board on Universal Service*, CC Docket Nos. 96-45 & 97-160, Fifth Report and Order, FCC 98-279, released October 28, 1998.

3/ Specifically, the WCM uses the switching, transport, and signalling information generated by the standard HAI wireline model (release 5.0A, which is also included on the enclosed disk). The principal difference is the use of wireless technology to estimate "loop" costs, as described in the enclosed documents. The WCM facilitates such a comparison with the outputs of the HAI wireline model, rather than the HCPM, because the HCPM has been tested, to date, using proprietary input data that have not been made fully available to outside parties. Once this issue has been resolved, we anticipate that it will be possible to revise the WCM to run as a "module" in conjunction with the HCPM.

HOGAN & HARTSON
L.L.P.

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DAVID L. SIERADZKI
COUNSEL
DIRECT DIAL (202) 637-6462
INTERNET DS0@DC2.HHLAW.COM

COLUMBIA SQUARE
555 THIRTEENTH STREET
WASHINGTON, DC 20004-
TEL (202) 637-5600
FAX (202) 637-5910

August 28, 1998

Magalie Roman Salas
Secretary
Federal Communications Commission
1919 M St., N.W.
Washington, D.C. 20554

Re: Federal-State Joint Board on Universal Service, CC Docket No. 96-45; Forward-Looking Mechanism for High Cost Support for Non-Rural LECs, CC Docket No. 97-160; Common Carrier Bureau Seeks Comment on Model Platform Development, DA 98-1587

Dear Ms. Salas:

I am enclosing for filing the original and five copies of Western Wireless Corporation's Comments on Model Platform Development, pursuant to the Public Notice in the above-captioned proceedings, DA 98-1587, released on August 7, 1998. Please contact me if you have any questions regarding this filing.

Respectfully submitted,

David Sieradzki

David L. Sieradzki
Counsel for Western Wireless Corp.

Enclosures

cc: Attached service list

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Federal-State Joint Board on Universal Service	)	CC Docket No. 96-45
	)	
Forward-Looking Mechanism for High-Cost Support for Non-Rural LECs	)	CC Docket No. 97-160
	)	
Common Carrier Bureau Seeks Comment On Model Platform Development	)	DA 98-1587
	)	

WESTERN WIRELESS CORPORATION
COMMENTS ON MODEL PLATFORM DEVELOPMENT

Western Wireless Corporation ("Western Wireless"), by its attorneys, submits these comments in response to the Public Notice, DA 98-1587, released August 7, 1998. 1/

Introduction

Western Wireless is a cellular and personal communications service ("PCS") carrier specializing in the provision of high-quality, affordable, and reliable wireless services to subscribers in both rural/high-cost and higher-density urban areas. Western Wireless currently provides commercial mobile radio service

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1/ Public Notice, *Common Carrier Bureau Seeks Comment on Model Platform Development*, CC Docket Nos. 96-45 & 97-160, DA 98-1587 (released Aug. 7, 1998) ("Public Notice").

("CMRS") to more than 700,000 subscribers under licenses in 22 states, covering over 60 percent of the continental United States, as well as Hawaii. In some regions, we believe it will be less costly to provide supported telecommunications services using wireless technologies than by using the wireline systems of incumbent local exchange carriers ("ILECs"). Thus, Western Wireless is seriously interested in providing universal service and helping realize the goals of Section 254 of the Act.

Western Wireless is participating in this proceeding to advance the overall policy goal of *technological and competitive neutrality* in the system for supporting universal service in high-cost and rural areas. 2/ To achieve this goal, the Commission must ensure, first, that consumers in high-cost and rural areas have the right to choose to obtain supported services from CMRS providers and other new entrants as well as from ILECs. Second, there must be parity between the revenue support available to all eligible telecommunications carriers, regardless of those carriers' technologies, rate structures, or regulatory status. Third, support must be available for mobile, as well as stationary, services that meet the Commission's definitions of supported universal service, and for wireless as well as wireline local loops.

2/ This goal already has been endorsed by the Commission and the Joint Board. *Federal-State Joint Board on Universal Service*, First Report and Order, 12 FCC Rcd 8776, 8858, 8932, ¶¶ 145, 287 (1997), *pet. for review pending.*

The HAI Wireless Model

The Commission has observed that "to the extent practical, the selected mechanism should estimate the cost of providing the supported services using wireless technology in areas where wireless technology is likely to be the least-cost, most efficient technology." 3/ At the same time, the Commission stated that it had received "almost no information regarding how to estimate such costs," and sought comment on "including an additional component in the mechanism that would compare the cost of providing service via a wireless network with the cost of providing service via a wireline network and would choose the lowest-cost technology to calculate the costs of providing the supported services." 4/

Western Wireless is endeavoring to fill this gap. We have retained HAI Consulting, Inc. to design a wireless cost model. This model estimates the cost of providing universal service over wireless networks in each ILEC wire center area, making it possible to determine whether it is less costly to provide service in that area using wireline technology (as projected by the model or platform to be selected by the Commission) or using wireless technology (projected by the HAI wireless cost model). The HAI wireless cost model can be used in conjunction with whatever platform or hybrid mechanism that the Commission selects to estimate

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3/ *Federal-State Joint Board on Universal Service, Forward-Looking Mechanism for High Cost Support for Non-Rural LECs*, CC Docket Nos. 96-45 & 97-160, Further Notice of Proposed Rulemaking, 12 FCC Rcd 18514, 18555, ¶ 99 (1997).

4/ *Id.*

the forward-looking cost, based on the most cost-effective technology, of providing universal service.

While the HAI wireless cost model is still in an early stage of development, Western Wireless believes that it will show that wireless technology is the least-cost technology in a substantial proportion of high-cost exchanges of non-rural ILECs as well as "rural telephone companies." Western Wireless intends to submit the actual model to the Commission within the next few months, and will provide additional information in the near term. We believe that this wireless cost model can be developed in time to incorporate its results as a factor in determining the level of non-rural ILEC high cost support beginning in July 1999.

Accordingly, Western Wireless strongly agrees with the Commission's tentative conclusion that, in geographic areas where the cost of wireless technology is less than the cost of wireline technology, "providing support based on the cost of a wireless network to provide the supported services would meet the statutory directive that support be 'sufficient.'" 5/ Moreover, the Commission *cannot* ignore the results of wireless cost models, because "basing support solely on wireline costs, when wireless technology may offer a less expensive option," certainly would *not* "be consistent with the Commission's conclusion that the mechanism should use the least-cost, most-efficient . . . technology available." 6/

5/ *Id.*, 12 FCC Rcd at 18556, ¶ 101.

6/ *Id.*

Features of the HAI Wireless Cost Model

The HAI wireless cost model estimates the total service cost, using wireless technology, of providing telecommunications in each ILEC wire center area. The model can reflect the engineering features of AMPS (*i.e.*, analog cellular) technology, which tends to be the least-cost wireless technology in high-cost and rural areas, or can reflect other technologies, such as various formats of digital cellular and PCS.

The HAI wireless cost model uses the switching, transport, and signalling information generated by the standard HAI wireline model, as well as standard expense-to-investment and uncollectible factors. The principal difference is the use of wireless technology to estimate "loop" costs. We believe the wireless model could be used as a "module" in connection with whatever basic wireline platform the Commission selects.

The model uses several conservative assumptions to project the costs of universal service using wireless technology. First, the model examines the cost of providing *fixed* wireless local loop service, which is more costly to deploy than *mobile* wireless service. The additional cost is due in part to the cost of special customer premises equipment ("CPE") used for converting signals from the AMPS format to the format used by standard wireline telephones. In addition, the model projects traffic loads, and the necessary infrastructure to handle such traffic (including cell sites and backhaul facilities), based on the amount of traffic that

users typically generate on wireline telephone networks, even though wireless mobile users typically generate significantly less traffic.

Two of the key factors in the model are the geographical location of customers 7/ and the traffic generated by those customers, which together are the main determinants of the number and location of cell sites. In turn, the geographic area covered by each cell site is correlated with the height of the tower, which is an important cost component. The model also accounts for the costs of microwave or landline backhaul from cell sites to wireless switching offices. The cost of spectrum is estimated based on data from the Broadband PCS D-E-F bands spectrum auctions, per-pop bid amounts, adjusted to reflect the difference between the amount of spectrum available in the D-E-F bands and that available to RSA cellular operators.

A summary presentation regarding the model is attached as Appendix A.

Platform Issues

The Public Notice seeks comment on geocoded customer location data and other approaches for modeling the location and grouping of customers. Western Wireless observes that the location of customers may be less significant with respect to the wireless cost model than it is for wireline cost models, for several reasons.

7/ We discuss the customer location issues raised in the Public Notice in the following section.

First, while customer location is a relevant factor in the cost of wireless service, it is less significant as a determinant of the total cost of service for wireless than for wireline service, due to obvious technological differences. In particular, given that the HAI wireless model estimates the cost of *total* service over a wireless network (*i.e.*, like the wireline models, it assumes that all customer demand is served by the wireless network), traffic capacity tends to overwhelm customer location and grouping as the most significant factor in determining the number of cell sites, in most cases for which the model has been run to date.

Moreover, once the assumption used in the HAI Wireless Model of *fixed* wireless service is relaxed, the fact that customers may use wireless telecommunications on a *mobile* basis renders the locations of their residences less significant as a cost determinant. For these reasons, the exact methodology used to determine customer location and grouping is less significant -- and requires less precision -- for the wireless model than for the wireline models.

Conclusion

In sum, wireless carriers like Western Wireless can play a significant role in providing supported universal service in high-cost areas. The wireless cost model that we are preparing to submit will demonstrate that wireless carriers can provide universal service, in a significant number of areas, more efficiently and at a lower cost than wireline ILECs. The Commission must take into account these wireless cost factors in its process of analyzing platforms and cost models for determining the level of support in high-cost areas. This will ensure that the total

cost of the high-cost support program is based on the most efficient and least costly technology -- and will empower Americans in high-cost areas to choose their universal service from a range of competing providers and technologies.

Respectfully submitted.

WESTERN WIRELESS CORPORATION

By: David Sieradzki

Michele C. Farquhar
David L. Sieradzki
HOGAN & HARTSON, L.L.P.
555 - 13th Street, N.W.
Washington, D.C. 20554
(202) 637-5600

Attorneys for Western Wireless Corp.

Gene DeJordy
Executive Director of
Regulatory Affairs
WESTERN WIRELESS CORP.
3650 - 131st Ave. S.E., Suite 400
Bellevue, WA 98006
(425) 586-8055

Dated: August 28, 1998

HWM

HAI Consulting, Inc. Wireless Model

Washington D.C.
August 26, 1998

HWM Overview

- Development sponsored by Western Wireless Corporation
- Engineering and cost model that calculates the cost of providing wireless local access
- Examines AMPS technology (cost effective in low density areas)
- Uses inputs from HM 5.0a wireline model results

HWM Features

- Incorporates cluster, cost and investment data from HM5.0a
- Provides results by state and wire center
- Estimates wireline and wireless investment, monthly costs and USF subsidy levels
- Provides data suitable for mapping

HWM Approach and Modeling Environment

- "Bottom Up" modeling process
- Uses Cluster data and current wireline access traffic loads to determine cell site, radio equipment and backhaul requirements
- Integrates transport, switching, signaling and other cost data from HM5.0a
- Model developed using Microsoft Excel and Access

Data Pre-processing

- Before creating a specific state model, data "pre-processing" is required
- Cluster Pre-processing (MS Access)
  - Pulls data for a state from HM 5.0a Cluster database
  - Based technology specific engineering parameters, clusters are analyzed and divided by line count
  - Cell site coverage and capacity requirements are determined
  - Data written to an Excel spreadsheet and copied into HWM template

Cluster Analysis

- Clusters over a certain line size are considered "Target Clusters"
  - Target Cluster area and line data are averaged
  - Target Clusters have cell sites built specifically to serve them with adequate height and channels to meet calculated coverage and traffic load
- "Non Target Clusters"
  - Area and line data are aggregated for clusters that do not meet requirements to be Target Clusters
  - Cell sites are specified to meet total coverage and traffic load for Non Target Cluster area

Data Pre-processing (Cont'd)

- HM 5.0a Pre-processing
  - HM 5.0a is run for all companies in a state. Default values are used.
  - Data from "Investment Input" output sheet aggregated by wire center into a single Excel worksheet
  - Aggregated data put into a HWM pre-processing workbook, resulting new worksheet copied into HWM template

Wireless Model Cost Factors

- Two cost factors derived from HM 5.0a results are used in HWM
  - Radio equipment monthly cost factor
    - The ratio of annual cost and overhead factors to total investment
    - Applied to wireless investment to determine a monthly cost
  - Retail uncollectible factor
    - The cost of uncollectible billings as a % of monthly cost

HWM State Model Template

- MS excel 97 workbook with integrated worksheets
  - "Model Assumptions"
  - "Lookup Tables"
  - "Cluster and Cell Analysis"
    - Cluster pre-processing data
  - "HM Costs"
    - HM 5.0a pre-processing data and factors
  - "WC Data"
  - "Summary Model Results"

HWM Variable Inputs

- Model Assumptions Worksheet
  - User interface for costs and inputs to the model
    - Capacity Variables
    - Backhaul Facilities Expense Variables
    - Recurring Subscriber Expense Variables
    - Subscriber and Subscriber Premises Investment, Acquisition and Operating Variables
    - USF Subsidy Thresholds
  - Also generates inputs for Cluster pre-processing

HWM Variable Inputs (Cont'd)

- Lookup Tables Worksheet
  - **Site Investment**
    - Varying height towers based on coverage requirement
    - Provides tower and structure investment detail
  - **Traffic Analysis and Radio Channel Investment**
    - Based on offered load from cluster lines in cell
  - **Microwave System Costs**
    - Based on backhaul requirements

The WC Data Worksheet

- The "Engine" of HWM
  - Performs all wireless cost and investment calculations by wire center
  - Integrates inputs, data and factors from HM 5.0a and Model Assumptions to produce results
  - Contrasts wireless vs. wireline results
  - Identifies wireless or wireline advantages by wire center
  - Performs certain results checking tests

Summary Model Results Worksheet

- State Geographic and Demand Data
  - General information in, and results from, the model
- Investment Summary for The Entire State
- USF Subsidy Summary Results
- USF Subsidy Analysis
  - Wireline vs. Wireless

Western Wireless Corp
HAI Consulting, Inc.

Summary Model Results (Cont'd)

- Estimated "Tapered" Subsidy
  - Analysis of the subsidy requirements if the most cost-effective technology is selected for each wire center
- Wireless vs. Wireline Costs - All Wire Centers
  - CLLIs With A Wireline Cost Advantage
  - CLLIs With A Wireless Cost Advantage
- Cell Site Coverage Tests
  - Engineering validation to be sure no CLLIs with a wireless cost advantage have had more cell sites calculated than can realistically be built

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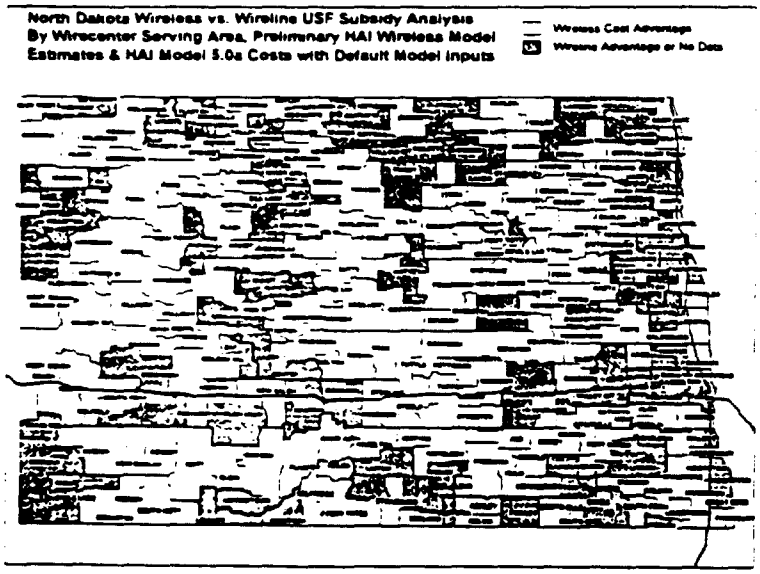
Other Model Features

- ILEC Summary Worksheet
  - Predefined Pivot Table for additional analysis
- Mapping Data Worksheet
  - Highlights certain results for export to MapInfo and similar mapping programs

Western Wireless Corp
HAI Consulting, Inc



Western Wireless Corp.
HAI Consulting, Inc.

HAI Consulting, Inc. Wireless Model

Version 4.0 Documentation

Prepared for Western Wireless Corporation

Table of Contents

Overview

HAI Consulting, Inc. (HAI) has been retained by Western Wireless Company (WW) to create an engineering based cost model (the HAI Wireless Model - HWM) that calculates the cost of providing wireless fixed access services. The basic goal of the modeling process is to examine the cost effectiveness of wireless access in comparison to wired access in low line density, high cost rural areas.

HWM produces investment calculations for a wireless access network, plus monthly cost per line, by ILEC wire center, for a selected state. These results are compared and contrasted to wireline monthly costs as determined by HAI Model 5.0a (HM),[1] and to line cost thresholds for Universal Service subsidies. HWM will summarize results to show the number of wire centers with wireline or wireless cost advantages, the estimated subsidy for each, and total subsidies.

The ultimate goal of the modeling process is to provide a platform to analyze various wireless technologies. Initially, however, analog cellular AMPS technology has been modeled, as it is the most widely implemented wireless technology in rural areas. It is anticipated that the assumptions and inputs for the AMPS model can readily be adapted for PCS, LMDS, or other wireless access technologies.

HWM works in conjunction with, but is not integrated to, HM. HWM draws on certain costs and cost factors from HM results as inputs.[2] HWM also makes use of location data in HM; specifically data that describes "Clusters" where population has been located in each state, as well as information concerning the serving ILEC wire center, cluster area and access lines. Component costs used to calculate network investments are based on HAI research and data provided by WW.

HWM takes a "bottom up" approach to the modeling process. It constructs a complete wireless network to serve access demand for the entire state. Based on cluster data from HM 5.0a database and traffic engineering assumptions appropriate to fixed access usage,[3] the number of cells sites (assumed to be located on towers of varying size matched to geographic coverage needed) and traffic channels needed to serve all residential, single line business and public line demand is calculated.

HWM employs two different cell types in the theoretical network it constructs, sectorized and unsectorized. Unsectorized cells employ a 360-degree coverage pattern for each frequency on the site. Unsectorized cells are typically used in lower density areas where aggressive frequency reuse for increased traffic capacity is not required.

Sectorized cells use highly directional antennae to confine the use of individual frequencies to specific directions. Sectorized cells are typically used in high-density areas to increase effective traffic handling capacity (by allowing aggressive frequency

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[1] HM models the cost of the wireline access networks in the United States. It has been submitted in the FCC's USF proceedings and a number of state proceedings.

[2] Based on results for each state using HM5.0a default inputs as of 12/1/98.

[3] Higher busy hour offered load and a lower blocking probability than standard mobile service.

reuse). The model assumes there is a limit of 384 radio channels available to serve each wire center. Based on the total traffic offered within the wire center, HWM selects one of the two cell types. The cell types are never used together within a single wire center.

The cell sites are populated with adequate radio channels to serve all residential, single line business and public line demand within their coverage radius. Once the cell site network is determined, the model calculates the necessary backhaul capacity needed for each site.

The final component for what is essentially the wireless equivalent of the feeder and distribution module of HM is the Customer Interface Unit (CIU). The CIU is similar to the Network Interface Device (NID) in the wireline model, but is more complex and serves to provide additional functions.[4]

Based on the total investment for the cell sites, CIUs, etc., HWM uses a cost factor derived from HM results for the current carriers (ILECs) in the state being modeled to determine a monthly cost for the investment. The cost factor includes the effects of capital carrying costs, maintenance, and various shared costs.

At this point, HWM integrates per-line wire center monthly cost data from HM for transport, switching,[5] signaling, local number portability, billing and billing inquiries, and uncollectibles. Summing the monthly cost of the wireless investment with the costs imported from HM, HWM arrives at the wireless per access line cost for each wire center.

In its present development state, running HWM requires three software applications that are part of the Microsoft Office 97 Professional application suite. Specifically, using a User Interface running under Visual Basic, Excel controls the fundamental modeling environment, including preliminary data processing done in Access. The User Interface prompts the user to select a state to model, and presents the opportunity to change a number of key inputs that affect results.[6] The Excel portion starts with the HWM.xls template workbook into which pre-processed data (explained below) is copied. In general, the act of copying in the data – via embedded Excel macros – generates the results and puts results data into summary sheets.

Model output is in the form of an Excel workbook. Within the results workbook are a number of worksheets. The first, ***Summary HWM Model Results***, summarizes the results generated for the selected state. The second, ***HWM Inputs***, displays inputs specific to the wireless features of the model, and allows many of them to be changed by

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[4] These include providing talk battery and ringing generator, along with call progress tone generation and DTMF detection to allow the use of standard telephones, coupled with a radio and external antennae.

[5] HWM assumes the wireless carrier will not install a switch for each current ILEC wire center. Rather, it assumes large centralized switching facilities will be deployed (which may also serve mobile traffic) to take advantage of scale economies. Thus, HWM uses an averaged per line switching cost for the state from HM.

[6] A user also has the opportunity to manipulate another set of inputs in the results workbook created after a state is run.

the user – which in turn is reflected in the summary results and in the worksheet that displays results on wire center by wire center basis, ***WC Data***.[7] The results of an HWM model "run" is saved as a new workbook in the form "HWM_XX.xls", where XX equals the two letter state code, and placed in the "Results" directory created when the model is installed.

Data Pre-processing

Before HWM can generate results for a state, two pre-processing steps are taken. These are incorporated into the process of generating results for a selected state automatically by the Visual Basic interface. When a user selects a state from the list of states presented the software then automatically runs a series of Access database queries. The resulting data is copied into the HWM.xls template workbook.

Cluster Pre-processing

First, the Cluster data for the state must be extracted from the HM Cluster Database by an Access routine based on inputs in the User Interface. Based on the maximum number of access lines that can be served by a full equipped sectorized cell site with a margin included for capacity overhead,[8] clusters are segregated into "High Density Clusters" (HDCs) and "Low Density Clusters" (LDCs).

An HDC has enough access lines to justify building one or more cell sites for service.[9] The HDCs are aggregated to determine an average HDC line size and area. Based on the average size and area, an average HDC cell site coverage area is determined. LDCs do not have enough access lines to justify building a cell site just for that cluster. This pre-processing data is copied into the HWM.xls template in the ***Cluster_Analysis*** worksheet.

An additional data point brought in during this process is the CLLI[10] Coverage Area Requirement (Sq. Mi.). Contained in an HWM Access table, this is an estimate of the coverage requirement for each CLLI. It was calculated by determining the distance in miles between the furthest east and west, and north and south clusters.[11] The two distances were then multiplied to establish a value in square miles of the area in which all the clusters for a CLLI are contained, and therefore radio coverage must be at least equivalent.

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[7] With the exception of certain input fields in ***HWM Inputs***, the state results workbook is protected and cannot be changed or altered.

[8] The default is 5 percent. In other words, an estimated 5 percent of the capacity of a sectorized cell is held aside to accommodate unexpected growth or demand spikes. This variable can be changed by the end user to sensitize the effect on results.

[9] Wireless systems can be either traffic capacity or radio coverage limited. In the case of High Density Clusters with more than one cell site, the additional cell site is for traffic capacity purposes.

[10] CLLI stands for Common Language Location Identifier and is used herein as an alternative term for "wire center".

[11] The source data for cluster locations is derived from the V and H coordinate system used by telephone companies. While V and H coordinates are not strictly on an east/west, north/south axis, the concept is used here for ease of understanding.

HM 5.0a Pre-processing

The second pre-processing step makes use of a set of results, created for each state using default inputs as of 12/1/98, from HM 5.0a. The results by wire center for from the HM5.0a Investment Module for each company in each state are aggregated into a single spreadsheet for the state. Each state aggregate wire center spreadsheet is processed to remove information concerning wireline loop expenses. They are then turned into an Access tables and placed into HWM. They are used individually therein to incorporate the cost elements and factors needed from HM into HWM by being copied into the ***HM Costs*** spreadsheet of the HWM.xls template when a particular state is analyzed.

At this time the inputs to HM5.0a can not be changed dynamically in HWM, as the processing of the HM results into the form needed for HWM is time consuming and not automated. Incorporating HWM into HM is a potential upgrade that is being considered.

Wireless Model Cost Factors

The following describes more completely two cost factors that are derived from HM5.0a and used in the wireless model to estimate the monthly cost of cellular equipment used for fixed wireless telephone service.

Radio equipment monthly cost factor

This factor is the ratio of annual cost (operating, maintenance, and capital carrying costs, plus applicable "overhead" factors, miscellaneous taxes and uncollectibles) to total investments, all divided by 12. The model assumes that economic life and expenses will be the same for the cellular radio equipment as it is for digital loop carrier equipment. It is computed easily as the total concentrator UNE cost (including SAI and DLC), adjusted for retail uncollectibles, divided by the sum of SAI and DLC investment, all divided by 12.

Retail uncollectible factor

This factor is required for calculating monthly service (retail) cost from UNE costs. The calculation is an inversion of the USF loop cost calculation found in cell HN3 of the Investment Input worksheet found in the HM5.0a Wire Center Expense Module:

((GE3+GF3+GG3+GH3)/(1-'96 Actuals'!F141))/B3)/12.

Here, '96 Actuals'!F 141 contains the retail uncollectible factor input to the Model via the ARMIS data sheet for the company under study, and GE3:GH3 are the distribution, NID, SAI/RT, and feeder UNE (annual) costs. B3 is the total line count for the wire center.

HWM Variable Inputs

Within the HWM.xls template are two worksheets, called "***HWM Inputs***" and "***Lookup Tables***" that contain key variable inputs that are used in the model to produce results.

HWM Inputs Worksheet

HWM Inputs allows a number of wireless cost elements and system parameters to be

varied to test model results:

Network Capacity Variables

- Peak Traffic Offered Per Fixed Access Line – In CCS, used to determine the number of access lines a site can serve given the minimum and maximum possible radio channels. To change this variable and determine the effects of the change the model must be re-executed and a new value entered in the User Interface prior to re-running HWM.
- Sectorized Cell Frequency Re-use Assumption – This sets the number of cells "C" in the equation of 1/C, indicating the occurrence of use for a particular frequency. This is used to check for Cells providing a coverage area too small to fit into a realistic engineering design. Default is seven times re-use. This variable can be changed on the ***HWM Inputs*** sheet of a state model run. ***WC Data*** and ***Summary HWM Model Results*** will be updated accordingly.
- Cell Sector Assumption – The number of sectors per sectorized cell site. Used in determining the number of access lines that can be served by a sectorized cell. Default is three sectors. To change this variable and determine the effects of the change the model must be re-executed and a new value entered in the User Interface prior to re-running HWM.
- Max Radio Channels Per Sectorized Cell – The number of channels is limited by the reuse factor. This also is used in determining the number of access lines served by the cell (channels/sectors gives the size of the trunk groups for the site). To change this variable and determine the effects of the change the model must be re-executed and a new value entered in the User Interface prior to re-running HWM.
- Max Access Lines Per Sectorized Cell – The number of access lines a sectorized cell site can serve before another cell site is required. This is a function of the number of sectors on a site, the number of available channels, and the offered traffic per access line. This cell on the ***HWM Inputs*** sheet is changed by manipulating the variables used to calculate it in the User Interface.
- High Density Cluster Capacity Margin – A capacity margin included in the calculation for the Minimum High Density Cluster (HDC) Access Lines that maintains extra capacity in a sectorized cell for demand spikes and some minimal growth in the cluster. Default is 5 percent. To change this variable and determine the effects of the change the model must be re-executed and a new value entered in the User Interface prior to re-running HWM.exe.
- Minimum High Density Cluster Access Lines – A function of the Max Access Lines Per Sectorized Cell and the HDC Capacity Margin. For instance, if the Max Access Lines Per Sectorized Cell Equals 300, and the HDC Capacity Margin is 5 percent, Minimum High Density Cluster Access Lines will be set at 285 access lines. This serves as the lower boundary to determine the size of clusters that will be categorized as HDCs.[12] This cell on the ***HWM Inputs*** sheet is changed by manipulating the variables in the User Interface used to calculate it.
- Max Radio Channels Per Unsectorized Cell – The maximum number of radio

[12] Minimum High Density Cluster Access Lines is a basic input used in the creation of the ***Cluster_Analysis*** sheet in Access pre-processing.

channels that a single unsectorized site can be equipped with. This ultimately defines the number of access lines that can be provided from a single unsectorized site. Default is 96 channels. This variable can be changed on the ***HWM Inputs*** sheet of a state model run. ***WC Data*** and ***Summary HWM Model Results*** will be updated accordingly.

- Max Access Lines Per Unsectorized Cell – The number of access lines an unsectorized cell site can serve before another cell site is required. This is a function of the available channels, and the offered traffic per access line. This cell on the ***HWM Inputs*** sheet is changed by manipulating the variables used to calculate it in the User Interface and ***HWM Inputs***. If the Max Radio Channels Per Unsectorized Cell variable on ***HWM Inputs*** sheet of a state model is changed, ***WC Data*** and ***Summary HWM Model Results*** will be updated accordingly.
- Minimum Radio Channels Per Any Type of Cell - The minimum number of channels a cell site can be equipped with. Default is seven. This variable can be changed on the ***HWM Inputs*** sheet of a state model run. ***WC Data*** and ***Summary HWM Model Results*** will be updated accordingly.
- Min Access Lines Per Any Type of Cell – The minimum number of access lines for a cell site with the minimum number of access lines. This cell on the ***HWM Inputs*** sheet is changed by manipulating the variables in the User Interface used to calculate it.

Miscellaneous Network Variables

- Monthly Cell Site Rent – The rent paid each month for the ground or rooftop leases used for cell sites. This variable can be changed on the ***HWM Inputs*** sheet of a state model run. ***WC Data*** and ***Summary HWM Model Results*** will be updated accordingly.
- Minimum Cell Coverage Area – Based on the coverage from the smallest tower. This is used to check for cells in a cluster that are too close together to fit in a realistic frequency re-use engineering design. This variable can be changed on the ***HWM Inputs*** sheet of a state model run. ***WC Data*** and ***Summary HWM Model Results*** will be updated accordingly.
- Cell Extenders Per Cell – A cost factor that calculates the investment for cell extenders based on the number of cells in a wire center. This variable can be changed on the ***HWM Inputs*** sheet of a state model run. ***WC Data*** and ***Summary HWM Model Results*** will be updated accordingly.
- Traffic Growth Percentage – This factor adds additional traffic load to each wire center and effectively forces HWM to build extra capacity for growth or peak load management purposes. Default is 0%. This variable can be changed on the ***HWM Inputs*** sheet of a state model run. ***WC Data*** and ***Summary HWM Model Results*** will be updated accordingly.

Backhaul Facilities Expense Variables[13]

With the exception of "Communication Paths Per T1" the following variables can be changed on the ***HWM Inputs*** sheet of a state model run. ***WC Data*** and ***Summary HWM Model Results*** will be updated accordingly.

- Backhaul Coding Rate (Kbps) - The transcoder data rate for encoding traffic for transport from cell sites to the switch.
- Coding Rate Backhaul Factor - An adjustment for overhead inherent in the voice coding process for signaling and control.
- Communication Paths Per T1 - The number of communication paths derived in a backhaul T1. This is a function of Coding Rate and the Backhaul Factor. This cell on the ***HWM Inputs*** sheet is changed by manipulating the variables used to calculate it.
- Cost Per Leased T1 - The monthly cost for a T1 leased from an ILEC or IXC and used to connect cell sites to switching or traffic concentrating facilities.
- Transcoder Cost Per T1 - The cost for transcoders to encode and decode full rate (64 kbps) PCM voice signals into lower data rates.
- Cost Per T1 Switch Port - The cost for a switch port that will directly interface to a T1 circuit.

Recurring Access Line Expense Variables

Data can be entered in the following fields in the ***HWM Inputs*** worksheet to override several cost elements that are imported from HM in the ***HM Cost*** sheet:

- End office usage - The monthly cost per access line for switching.
- Billing/Bill Inquiries - The monthly cost per access line for producing subscriber bills and responding to customer inquiries.
- Directory Listings - The monthly cost per access line for directory listings
- LNP (when available) - The monthly cost per access line for local number portability, when it is available.
- Uncollectibles as a % of all other monthly costs - A cost factor from HM applied to the total monthly cost per wire center to account for uncollectible subscriber bills.

Subscriber Premises Investment, Acquisition and Operating Variables

- CIU Cost - The cost of the Customer Interface Unit, considered an investment.
- CIU Installation Cost - The cost of installing a CIU
- CIU Annual Maintenance cost - The annual cost per installed CIU for maintenance such as checking or changing batteries.
- Marketing Cost Per Gross Line Added (Customer Acquisition Cost) – The marketing cost of acquiring a customer. Currently set at $0 for the current model which assumes the wireless network serves all customers.
- Spectrum Investment Per POP – The default of $3.87 is based on the averaged net amount bid for BTAs during the PCS D, E & F block auction in the modeled state, excluding BTAs containing an MSA. In other words, the cost of spectrum in more

[13] HDCs are presumed to be in populated areas with access to wireline facilities and therefore uses leased T1 lines for backhaul. For LDCs a combination of private microwave and leased T1 lines are used. Microwave costs are on the ***Lookup Tables*** worksheet.

rural areas.

- POPs Per Household – Used to translate the Spectrum Investment per POP into a cost per Household. This in turn is used to calculate the investment per CLLI for spectrum.

USF Subsidy Thresholds (From HM 5.0a)

- Residential Universal Service Subsidy Threshold - The monthly residential access line cost above which the line is subsidized. The default is $31.00.
- Business Universal Service Subsidy Threshold - The monthly single business access line cost above which the line is subsidized. The default is $51.00.

Lookup Tables Worksheet

The second worksheet containing variable inputs for HWM is ***Lookup Tables***. In this sheet a number of tables have been created that the model uses to match inputs to variable data, such as differing coverage requirements and traffic loads.

The tables in this worksheet include:

- Site Investment - This table is used to match a cell type (A-E) to a geographic coverage requirement. Based on the cell type (which varies by tower height and the investment required for construction) the model then can pull investment data in from the same table.
- Traffic Analysis and Radio Channel Investment - This table contains information on the number of radio channels needed to serve a range of offered loads (which are calculated based on the busy hour parameters in ***HWM Inputs*** and the number of lines in the High Density or LDC). Based on the number of channels required for a cell site, the table also contains data on the cost of the radio equipment to be used in investment calculations. The investment data is based on averaged cost per channel for a number of radio equipment vendor's products.
- Microwave Lookup - This table is used to incorporate the investment cost for backhaul microwave links into the model. Based on the number of T1 channels needed, the table provides a range of microwave system costs.[14]
- State Lookup - This table looks up the state abbreviation that comes in with the pre-processed data and provides the whole state name or the area for the state.
- Cell Extender Lookup – This small table contains the cost information for a single cell extender.

The *WC Data* Worksheet

The assumptions and pre-processing data are integrated in a large HWM.xls template spreadsheet called ***WC Data***. The information for each wire center is imported, and the costs for each wire center are calculated. Following is a list of information contained, and results calculated, in this sheet (starting with column "A":

[14] Tower and equipment shelter and power costs are part of the cost of the cell site, so this table only needs to provide the cost of the microwave system electronics and antennae.

Wirecenter Data

- State – Equal to the corresponding cell value in the State column in ***Cluster_Analysis***. This identifies the state being analyzed.
- CLLI – Equal to the corresponding cell value in the CLLI column in ***Cluster_Analysis***. This is the identifying code for the wire center being analyzed.
- Company – Equal to the corresponding cell value in the Company column in ***Cluster_Analysis***. This is the company that owns the wire center.
- LOCALITY – Equal to the corresponding cell value in the Locality column in Cluster_Analysis. This gives an indication of the location of the wire center.
- CLLI Clusters – Equal to the corresponding cell value in the CLLI Clusters column in Cluster_Analysis.
- CLLI ResBisPub Lines – Equal to the corresponding cell value (rounded up to the nearest whole number) in the CLLI ResBisPub Lines column in ***Cluster_Analysis***.
- Households – Matches the CLLI with the wire center code in ***HM Costs*** and returns the value for the number of households from ***HM Costs***.
- CLLI Coverage Area Requirement (Sq. Mi.) – Equal to the corresponding cell value in the Coverage Area Requirement column from ***Cluster_Analysis***.
- CLLI Offered Traffic (CCS) – A function of the number of CLLI ResBusPub lines multiplied by Peak Traffic Offered in ***HWM Inputs***.
- CLLI Offered Traffic With Growth Margin – The traffic calculated above multiplied by 1 plus the Traffic Growth Percentage in ***HWM Inputs***.
- CLLI Traffic With Growth Margin Under Unsectorized Limits? (1=yes) – Test to determine if the Offered Traffic With Growth Margin requires the capacity generated by using Sectorized cells. It tests by comparing against a figure in the Lookup Tables sheet that represents the maximum traffic handled by 384 channels.[15] Based on this test the CLLI's cell structure will be either sectorized or unsectorized and subsequent modeling operations will be performed accordingly.
- Minimum Lines In A Cluster to Justify a Cell – Equal to the number in ***Cluster_Analysis*** column labeled Minimum Cluster Line Count. That in turn is passed through from ***HWM Inputs***.

High Density Cluster Data and Cell Calculations

- "High Density Clusters" (HDCs) Above Min Line Threshold – Equal to the corresponding value in the HD Clusters column in ***Cluster_Analysis***. This is the number of HDCs in the CLLI.
- Total # of Lines in HDCs – Equal to the corresponding value (rounded up to an integer) from the HDC ResBusPub Lines column in ***Cluster_Analysis.***
- Average # of Lines in HDCs – Equal to the corresponding value (rounded up to an integer) from the Avge HDC Lines column in ***Cluster_Analysis.***
- Total HDC Area – Equal to the corresponding value from the Sum of HDC Area column in ***Cluster_Analysis.***
- Average HDC Area – Tests to be sure there are HDC clusters, if HDC clusters >0, then returns Total HDC Area/High Density Clusters.

[15] The capacity figure for the unsectorized cell test is equal to the capacity of 96 channels multiplied by four. The model assumes a maximum of 384 available channels at a maximum of 96 per site.

- Maximum Lines Per Sectorized Cell – Equal to the Max Access Lines Per Sectorized Cell in ***HWM Inputs***.
- Sectorized Cells Per HDC – Refers to the test to see if the CLLI is under the unsectorized traffic limit, if not then tests to see if there are HDCs. If there are HDCs, divides the number of lines in HDCs by the maximum lines per sectorized cell. If within unsectorized limit, or if there are no HDCs, returns 0.
- Total Sectorized HDC Cells – Refers to the test to see if the CLLI is under the unsectorized traffic limit, if not then multiplies the number of sectorized cells per HDC by the number of HDCs. If within unsectorized limit returns 0.
- Lines Per Sectorized HDC Cell – Refers to the test to see if the CLLI is under the unsectorized traffic limit, if not then tests to see if there are HDCs. If there are HDCs, the total of HDC lines is divided by the number of HDC sectorized cells. If not under unsectorized limit, or if there are no HDCs, returns 0.
- Lines Per Sector for HDC Sectorized Cells – Divides the number of Lines per Sectorized HDC Cell by the Cell Sector Assumption in ***HWM Inputs***.
- Offered Load (CCS) Per Sector for HDC Sectorized Cells – If Lines per Sector = 0, returns a 0. Otherwise, multiplies the Lines per Sector by Peak Offered Traffic Per Fixed Access Line in ***HWM Inputs***.
- Required Channels Per Sector – If Offered Load Per Sector = 0, returns a 0. Otherwise, looks up the Offered Load in **the Traffic Analysis and Radio Channel Investment** table in ***Lookup Tables*** sheet, and returns the number of channels needed to serve that load.
- Channels Per Sectorized Cell – If Required Channels per Sector = 0, returns a 0. Otherwise, multiplies the Channels per Sector times the Cell Sector Assumption in ***HWM Inputs***.
- Coverage Area Per HDC Sectorized Cell – If Sectorized Cells per HDC = 0, returns a 0. Otherwise, divides the Average HDC Area by the Number of Cells per HDC. This determines the coverage that must be achieved from each HDC site, and therefore the type of cell that must be employed.
- Maximum Lines Per Unsectorized Cell – Equal to Max Access Lines Per Unsectorized Cell in ***HWM Inputs***.
- Unsectorized Cells Per HDC – Refers to the test to see if the CLLI is under the unsectorized traffic limit, if it is then tests to see if there are HDCs. If there are HDCs, divides the number of lines in HDCs by the maximum lines per unsectorized cell. If not within unsectorized limit, or if there are no HDCs, returns 0.
- Total Unsectorized HDC Cells– Refers to the test to see if the CLLI is under the unsectorized traffic limit, if it is then multiplies the number of unsectorized cells per HDC by the number of HDCs. If over unsectorized limit returns 0.
- Lines Per Unsectorized HDC Cell – Refers to the test to see if the CLLI is under the unsectorized traffic limit, if it is then tests to see if there are HDCs. If there are HDCs, the total of HDC lines is divided by the number of HDC sectorized cells. If not within unsectorized limit, or if there are no HDCs, returns 0.
- Offered Load (CCS) Per HDC Unsectorized Cell – Multiplies the Lines per Lines Per Unsectorized HDC Cell by Peak Offered Traffic Per Fixed Access Line in ***HWM Inputs***.

- Channels Per HDC Unsectorized Cell – If Offered Load (CCS) Per HDC Unsectorized Cell = 0, returns a 0. Otherwise, performs a lookup operation of Offered Load in **Traffic Analysis and Radio Channel Investment** table of the ***Lookup Tables*** worksheet and returns the number of channels needed to serve the indicated traffic load.
- Total Channels Used for Unsectorized HDC Cells – Multiplies the number of unsectorized cells per HDC by the number of HDCs.
- Coverage Area Per HDC Unsectorized Cell (Sq. Mi.) – If Unsectorized Cells per HDC = 0, returns a 0. Otherwise, divides the Average HDC Area by the number of Unsectorized Cells per HDC. This determines the coverage that must be achieved from each HDC site, and therefore the type of unsectorized cell that must be employed.
- Total HDC Cells – Refers to test for sectorized or unsectorized cell structure and selects the appropriate cell calculation.
- Cells Per HDC – Tests for the presence of HDCs in the CLLI, if present divides Total HDC Cells by HDCs. If no HDCs returns 0.
- Lines Per HDC Cell – Tests for the presence of HDC Cells. If present divides Total # of Lines in HDCs by Total HDC Cells. If no HDCs returns 0.
- Channels Per HDC Cell – Refers to test for sectorized or unsectorized cell structure and selects the appropriate channels per cell calculation.
- Coverage Area per HDC Cell (Sq. Mi) – Refers to test for sectorized or unsectorized cell structure and selects the appropriate cell coverage area calculation.
- HDC Cell Type – If Coverage Area per HDC Cell (Sq. Mi.) = 0, returns a null (empty) value. Otherwise, performs a lookup operation of Coverage Area per HDC Cell (Sq. Mi.) in the **Site Investment** table of the ***Lookup Tables*** worksheet and returns the letter designation of the appropriate size tower to meet the coverage area requirement.
- Coverage From HDC Cells – If Total HDC Cells = 0, returns a 0. Otherwise, performs a lookup operation of HDC Cell Type in the **Site Investment** table of the ***Lookup Tables*** worksheet, returns estimated maximum coverage area of the HDC Cell Type and multiplies that value by Total HDC Cells to estimate total coverage by HDC Cells within the CLLI.
- Investment for Cell Type – If Total HDC Cells = 0, returns a 0. Otherwise, performs a lookup operation of HDC Cell Type in the **Site Investment** table of the ***Lookup Tables*** worksheet, returns the investment for the HDC Cell Type.
- Total Site Investment for HDC Cells – Multiplies the Investment for Cell Type by Total HDC Cells.

Low Density Cluster Data and Cell Calculations

- Low Density Clusters ("LDCs") In CLLI – Subtracts the "High Density Clusters" (HDCs) Above Min Line Threshold from CLLI Clusters to arrive at the number of Low Density Clusters in the CLLI.
- Total Lines in "Low Density Clusters" (LDCs = Total Clusters-HDCs) – Equal to the Rounded-up value of LDC Lines in ***Cluster_Analysis*** for the CLLI.
- Total Area in LDCs – Equal to the Rounded-up value of LDC Cluster Area in ***Cluster_Analysis*** for the CLLI.

- Total Area Outside of HDCs – CLLI Coverage Area Requirement (Sq. Mi.) minus Total HDC Area.
- LDC Cells Required On a Coverage Basis – If there are no LDCs = 0. Otherwise if the Total Area Outside of HDCs is greater than the coverage area of the largest cell type in **Site Investment** table of the ***Lookup Tables*** worksheet, it divides the Total Area by the coverage area by the largest cell coverage area and rounds up. If Total Area Outside of HDCs is less than the largest cell coverage area it returns a 1.
- Sectorized Cells Required for LDC Traffic – Firsts tests for LDCs in the CLLI, then refers to the test to see if the CLLI is outside the unsectorized traffic limit. If outside the limit, divides the number of lines in LDCs by the maximum lines per sectorized cell. If within unsectorized limit, or if there are no LDCs, returns 0.
- Greater of Coverage or Sectorized Traffic Cells – Selects the greater number of cells calculated by LDC Cells Required On a Coverage Basis or Sectorized Cells Required for LDC Traffic.
- Lines Per Sectorized LDC Cell – If there are no LDCs, = 0. Otherwise, refers to the test to see if the CLLI is over the unsectorized traffic limit, if it is Total Lines in "Low Density Clusters" is divided by Greater of Coverage or Sectorized Traffic Cells. If within unsectorized limit, returns 0.
- Lines Per Sector for LDC Sectorized Cells – Refers to the test to see if the CLLI is over the unsectorized traffic limit, if it is then Lines Per Sectorized LDC Cell is divided by the Cell Sector Assumption in ***HWM Inputs***. If within unsectorized limit, returns 0.
- Offered Load (CCS) Per Sector for LDC Sectorized Cells – Refers to the test to see if the CLLI is over the unsectorized traffic limit, if it is then Lines Per Sector for LDC Sectorized Cells is multiplied by Peak Offered Traffic Per Fixed Access Line in ***HWM Inputs***. If within unsectorized limit, returns 0.
- Required Channels Per Sector – If Offered Load Per Sector = 0, returns a 0. Otherwise, looks up the Offered Load in **the Traffic Analysis and Radio Channel Investment** table in ***Lookup Tables*** sheet, and returns the number of channels needed to serve that load.
- Channels Per Sectorized LDC Cell – Multiplies Required Channels Per Sector by the Cell Sector Assumption in ***HWM Inputs.***
- Unsectorized Cells Required For LDC Traffic – Refers to the test to see if the CLLI is within the unsectorized traffic limit. If within the limit, divides the number of lines in LDCs by the Maximum Lines Per Unsectorized Cell. If not within unsectorized limit, returns 0.
- Greater of Coverage or Unsectorized Traffic LDC Cells – Refers to the test to see if the CLLI is within the unsectorized traffic limit. If within the limit, selects the greater number of cells calculated by LDC Cells Required On a Coverage Basis or Unsectorized Cells Required for LDC Traffic.
- Average Offered Traffic (CCS) per Unsectorized LDC Cell – Checks for presence of LDCs and refers to the test to see if the CLLI is within the unsectorized traffic limit. If LDCs present and if within unsectorized limit, divides is Total Lines in "Low Density Clusters" by Greater of Coverage or Unsectorized Traffic LDC Cells and multiplies the result by

- Channels Required Per Unsectorized LDC Cell – If Offered Load (CCS) Per LDC Unsectorized Cell = 0, returns a 0. Otherwise, performs a lookup operation of Offered Load in **Traffic Analysis and Radio Channel Investment** table of the ***Lookup Tables*** worksheet and returns the number of channels needed to serve the indicated traffic load.
- Total LDC Cells in CLLI – Refers to the test to see if the CLLI is within the unsectorized traffic limit. If within the limit, selects Greater of Coverage or Unsectorized Traffic LDC Cells, if not within limit selects Greater of Coverage or Sectorized Traffic Cells.
- Lines Per LDC Cell – If Total LDC Cells in CLLI = 0, returns 0. Otherwise, divides Total Lines in "Low Density Clusters" by Total LDC Cells in CLLI.
- Channels Per LDC Cell – Refers to the test to see if the CLLI is within the unsectorized traffic limit. If within the limit, Channels Required Per Unsectorized LDC Cell, if not within limit selects Channels Per Sectorized LDC Cell.
- Coverage Area per LDC Cell (Sq. Mi) – If Low Density Clusters ("LDCs") In CLLI = 0, then return 0. If Low Density Clusters ("LDCs") In CLLI = 1, then = Total Area in LDCs. Otherwise, Total Area Outside of HDCs divided by Total LDC Cells in CLLI.
- HDC +LDC Capacity Limits Check[16] – If Total HDC Cells = 0, sets check equal to 1. If HDC cells are present refers to the test to see if the CLLI is within the unsectorized traffic limit. If within the limit then divides CLLI ResBisPub Lines by the number of HDC Cells, if the result is less than the limit for channels in an *unsectorized* cell sets check = 0, otherwise sets it to 1. If CLLI is outside the unsectorized limit, in other words is sectorized, CLLI ResBisPub Lines is divided by the number of HDC cells and if the result is less than the limit for channels in a *sectorized* cell the check is set = 0, otherwise it is set to 1.
- Cell Type of LDC Cells – If Total LDC Cells in CLLI is greater than or equal to 1 moves on to the functions following, otherwise returns a null (empty) cell. If Coverage Area per LDC Cell (Sq. Mi.) is greater than 0, a lookup operation is performed of Coverage Area per LDC Cell (Sq. Mi.) in the **Site Investment** table of the ***Lookup Tables*** worksheet and the letter designation of the appropriate size tower to meet the coverage area requirement is returned.
  If Coverage Area per LDC Cell (Sq. Mi.) is less than 0, and if HDC +LDC Capacity Limits Check = 1, then cell type is set equal to HDC Cell Type.[17] Otherwise a lookup operation is performed of Coverage Area per LDC Cell (Sq. Mi.) in the **Site Investment** table of the ***Lookup Tables*** worksheet, and the letter designation of the appropriate size tower to meet the coverage area requirement is returned.
- Estimated Max Coverage From LDC Cells – If Total LDC Cells in CLLI = 0, returns a 0. Otherwise, performs a lookup operation of LDC Cell Type in the **Site Investment** table of the ***Lookup Tables*** worksheet, returns estimated maximum coverage area of the LDC Cell Type and multiplies that value by Total LDC Cells to estimate total coverage by LDC Cells within the CLLI.

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[16] The purpose of this check is to assist in determining if LDC cells must be built, or if the HDC cells provide adequate geographic coverage for the entire CLLI – and LDC traffic needs can be met by adding channels to HDC cells.

[17] This is only the case when HDC cells do not have enough available channel capacity to accommodate LDC traffic capacity too (even though they provide adequate geographic coverage).

- Site Investment for Cell Type – If Total LDC Cells = 0, returns a 0. Otherwise, performs a lookup operation of LDC Cell Type in the **Site Investment** table of the ***Lookup Tables*** worksheet, returns the investment for the LDC Cell Type.
- Total Site Investment for LDC Cells – Multiplies the Investment for Cell Type by Total LDC Cells

CLLI Cell Calculation and Investment Summary

- Adjusted Total Cells In CLLI – If Cell Type of LDC Cells = "CHNLS ONLY" then selects Total HDC Cells, otherwise adds Total HDC Cells to Total LDC Cells in CLLI.
- Average Lines Per Cell – CLLI ResBisPub Lines divided by Adjusted Total Cells In CLLI.
- Estimated Max Coverage From CLLI Cells – Sums Coverage From HDC Cells and Estimated Max Coverage From LDC Cells.
- Total CLLI Cell Site Investment – Sums Total Site Investment for HDC Cells and Total Site Investment for LDC Cells.
- CLLI Total Cell Site Rent Per Month – Multiplies Adjusted Total Cells In CLLI by the Monthly Cell Site Rent in ***HWM Inputs***.
- Radio Channels (Trunks) Needed Per HDC Cell – If "High Density Clusters" (HDCs) Above Min Line Threshold = 0, then returns 0. Otherwise, if Channels Per HDC Cell is less than or equal to 3, returns 3; if more then returns a value equal to Channels Per HDC Cell.
- Per Cell HDC Radio Equipment Investment – Performs a lookup operation Radio Channels (Trunks) Needed Per HDC Cell in **Traffic Analysis and Radio Channel Investment** table of the ***Lookup Tables*** worksheet and returns the investment to equip a cell with the indicated number of channels.
- Total HDC Radio Equipment Investment – Multiplies the Per Cell HDC Radio Equipment Investment by Total HDC Cells.
- Radio Channels (Trunks) Needed Per LDC Cell – Low Density Clusters ("LDCs") In CLLI = 0, then returns 0. Otherwise, if Channels Per LDC Cell is less than or equal to 3, returns 3; if more then returns a value equal to Channels Per LDC Cell.
- Per Cell LDC Radio Equipment Investment – Performs a lookup operation Radio Channels (Trunks) Needed Per LDC Cell in **Traffic Analysis and Radio Channel Investment** table of the ***Lookup Tables*** worksheet and returns the investment to equip a cell with the indicated number of channels.
- Total LDC Radio Equipment Investment – Multiplies the Per Cell LDC Radio Equipment Investment by Total LDC Cells.
- Total CLLI Cell Extender Investment – Equal to Adjusted Total Cells In CLLI multiplied by Cell Extenders per Cell in HWM Inputs, multiplied by the **Cost of Cell Extender** in ***Lookup Tables***.
- Total CLLI Radio Equipment Investment- Equal to the sum of Total LDC Radio Equipment Investment plus Total HDC Radio Equipment Investment plus Total CLLI Cell Extender Investment.
- Total CLLI Site and Radio Equipment Investment- Equal to the sum of Total CLLI Cell Site Investment plus Total CLLI Radio Equipment investment.

- Estimated Monthly CLLI Site and Radio Equipment Cost – Equal to Total CLLI Site and Radio Equipment Investment multiplied by Distribution and other Investment monthly cost factor.

Backhaul Calculations

- Per HDC Cell Back Haul T1's – If Radio Channels (Trunks) Needed Per HDC Cell is equal to 0, then use the value of 0. Otherwise use the value in Radio Channels (Trunks) Needed Per HDC Cell (in ***WC Data***) divided by Voice Paths Per T1 (***HWM Inputs***) and round up to the nearest whole number.
- Total HDC Cell Back Haul T1's- Equal to Per HDC Cell Back Haul T1's multiplied by Total HDC Cells.
- HDC Cell Monthly Back Haul Cost- Equal to Total High Density Cell Back Haul T1's multiplied by Cost Per Leased T1 in ***HWM Inputs***.
- Per Line, HDC Cell Monthly Backhaul Cost – If HDC Cell Monthly Back Haul Cost is equal to 0, return a 0. Otherwise, return the value of HDC Cell Monthly Back Haul Cost divided by Total # of Lines in HDCs.
- Back Haul T1's Per LDC Cell – If Radio Channels (Trunks) Needed Per LDC Cell is equal to 0, then use the value of 0. Otherwise use the value in Radio Channels (Trunks) Needed Per LDC Cell (in ***WC Data***) divided by Voice Paths Per T1 (in ***HWM Inputs***) and then round up to the nearest whole number.
- Total Back Haul T1's For LDC Cells – Equal to Back Haul T1's Per LDC Cell multiplied by Select the Greater of Traffic or Coverage Cells.
- Microwave Backhaul Investment Per Low Density Cell – If Back Haul T1's Per LDC Cell is equal to 0, uses the value of 0, otherwise match Back Haul T1's Per LDC Cell with T1 Capacity in **Microwave Lookup** from ***Lookup Tables*** and return the value in Cost in ***Lookup Tables***.
- Total LDC Cell Back Haul Investment – Equal to Microwave Backhaul Investment multiplied by Select the Greater of traffic or Coverage Cells.
- Wireline T1 Portion of Microwave Backhaul – Equal to Back Haul t1's Per LDC Cell multiplied by Select the Greater of Traffic or Coverage Cells, multiplied by Cost per leased T1 in ***HWM Inputs***.
- Monthly Cost For Microwave – Equal to product of Total LDC Cell Back Haul Investment multiplied by Distribution and other Investment monthly cost factor plus Wireline T1 Portion of Microwave Backhaul. .
- Per Line, Monthly Cost for Microwave – If Monthly Cost for Microwave is equal to 0, returns a 0. Otherwise, return Monthly Cost for Microwave divided by Lines Outside HDCs.
- CLLI Total Backhaul T1s –Equal to the sum of Total Back Haul T1's For LDC Cells plus Total HDC Cell Back Haul T1's.
- CLLI Total Transcoder Investment- Equal to CLLI Total Backhaul T1s multiplied by Transcoder cost per T1 in ***HWM Inputs***.
- Monthly CLLI Total Transcoder Cost – Equal to CLLI Total Transcoder Investment multiplied by Distribution and other investment monthly cost factor.
- CLLI Total T1 Switch Port Investment – Equal to CLLI Total Backhaul T1s multiplied by Cost per T1 Switch Port in ***HWM Inputs***.

- Monthly CLLI Total T1 Switch Port Cost – Equal to CLLI Total T1 Switch Port Investment multiplied by Distribution and other Investment monthly cost factor.
- Total Monthly Back Haul Cost for ALL Cells – Equal to The sum of Monthly Cost For Microwave, HDC Cell Monthly Backhaul Cost, Monthly CLLI Total Transcoder Cost, and Monthly CLLI Total T1 Switch Port Cost.

CIU Calculations

- CIU Equipment Investment – Equal to CLLI ResBusPub Lines multiplied by Customer Interface Unit (CIU) Cost in ***HWM Inputs***.
- CIU Installation Cost – Equal to CLLI ResBusPub Lines multiplied by CIU Installation Cost in ***HWM Inputs***.
- Total CIU Investment – Equal to the sum of CIU Installation Cost plus CIU Equipment Investment.
- Estimated Monthly CIU Cost – Equal to Total CIU Investment multiplied by Distribution and other Investment monthly cost factor.
- CIU Annual Maintenance – Equal to CLLI ResBusPub Lines multiplied by CIU Annual Maintenance Cost in ***HWM Inputs***.
- CIU Monthly Maintenance – Equal to CIU Annual Maintenance divided by 12.

Investment Summary, Monthly Expenses, Cost Factors and Wireline Costs from HM 5.0

- Total CLLI Site, RF Equipment, Microwave, Transcoder and CIU Investment – Equal to the sum of the values for Total CLLI Site and Radio Equipment Investment, Total LDC Cell Back Haul Investment, CLLI Total Transcoder Investment, and Total CIU Investment.
- Distribution and other investment monthly cost factor – Matches CLLI with wire center (in ***HM Costs***) and return the value in radio eqpt monthly cost factor from ***HM Costs***.
- Retail uncoll. Factor – Equal to the value in wtd avg retail uncoll in ***HM Costs***.
- HM Wireline Feeder – Matches CLLI with wire center (in ***HM Costs***) and return the value in feeder from ***HM Costs***.
- HM Wireline Loop Cost – Matches CLLI with wire center (in ***HM Costs***) and return the value in wireline loop cost from ***HM Costs***.
- Per Line, Estimated Monthly Site & Radio Eq. Cost – Equal to Estimated Monthly CLLI Site and Radio Equipment Cost divided by CLLI ResBusPub Lines.
- Per Line, Monthly Cost for All Back Haul – Equal to Total Monthly Back Haul Costs for ALL Cells divided by CLLI ResBusPub Lines.
- Per Line, Estimated Monthly CIU Cost- Equal to Estimated Monthly CIU Cost divided by CLLI ResBusPub Lines.
- Per Line, CIU Monthly Maint. – Equal to CIU Monthly Maintenance divided by CLLI ResBisPub Lines.
- Per Line, Monthly Site Rental – Equal to CLLI Total Cell Site Rent Per Month divided by CLLI ResBisPub Lines.
- HM wtd avg EO usage – If End office usage (in ***HWM Inputs***) is equal to 0, then match CLLI with wire center (in ***HM Costs***) and return the value in wtd avg EO

usage in ***HM Costs***. Any other cases use the value in End office usage (in ***HWM Inputs***).

- HM Signaling – Matches CLLI with wire center (in ***HM Costs***) and return the value in Signaling from ***HM Costs***.
- HM Transport – Matches CLLI with wire center (in ***HM Costs***) and return the value in Transport from ***HM Costs***.
- HM Billing/Bill Inquiries – If Billing/Bill Inquires (in ***HWM Inputs***) is equal to 0, then match CLLI with wire center (in ***HM Costs***) and return the value in Billing/Bill Inquires in ***HM Costs***. Any other cases use the value in Billing/Bill Inquires (in ***HWM Inputs***).
- HM Directory Listing – If Directory Listing (in ***HWM Inputs***) is equal to 0, then match CLLI with wire center (in ***HM Costs***) and return the value in Directory Listing in ***HM Costs***. Any other cases use the value in Directory Listing (in ***HWM Inputs***).
- LNP (when available) – If LNP (when available) (in ***HWM Inputs***) is equal to 0, then match CLLI with wire center (in ***HM Costs***) and return the value in LNP (when available) in ***HM Costs***. Any other cases use the value in LNP (when available) (in ***HWM Inputs***).
- Per Line, Per Month, Customer Acquisition Cost – Equal to Marketing Cost per Gross Line Added multiplied by Distribution and other investment monthly cost factor.
- Total Spectrum Investment – Equal to Households multiplied by POPs Per Household in ***HWM Inputs*** multiplied by Cost of Spectrum per POP.
- Total Monthly Spectrum Cost – Equal to Total Spectrum Investment multiplied by Distribution and other investment monthly cost factor.
- Per Line Monthly Spectrum Cost – Equal to Total Monthly Spectrum Cost divided by CLLI ResBusPub Lines.
- Cost Before Uncollectibles – Equal to the sum of all values, left to right, from Per Line, Estimated Monthly Site & Radio Eq. Cost to Per Line, Per Month, Customer Acquisition cost plus Per Line Monthly Spectrum Cost.

<u>CLLI Wireless and Wireline Cost and Estimated Subsidy Summaries</u>

- Wireless Model Total Monthly CLLI Cost – Equal to Wireless Model Total Monthly Cost Per Line multiplied by CLLI ResBisPub Lines.
- HM Total wireline CLLI monthly cost – Equal to HM Total Wireline monthly cost per line multiplied by CLLI ResBisPub Lines.
- Wireless Model Total Monthly Cost Per Line – Equal to Cost Before Uncollectibles multiplied by (1 plus retail uncoil factor).
- HM Total wireline monthly cost per line – Matches CLLI with wire center in ***HM Costs*** and return the value in Total wireline monthly cost per line from ***HM Costs***.
- RESIDENTIAL LINE HM Total wireline CLLI monthly cost – Matches CLLI with wire center in ***HM Costs*** and return the value in @ Residence usage per line from ***HM Costs***.
- BUSINESS LINE HM Total wireline CLLI monthly cost – Matches CLLI with wire center in ***HM Costs*** and return the value in @ Business usage per line from ***HM Costs***.

- Delta: Wireless to Wireline – Equal to Wireless Model Total Monthly Cost Per Line minus HM Total wireline monthly cost per line.
- Wireless Advantage? – If Delta: Wireless to Wireline is less than or equal to 0.01, return a YES. Otherwise return a no.
- Wireless Advantage % – Delta: Equal to Wireless to Wireline multiplied by –1, then divided by HM Total wireline monthly cost per line.
- Eligible for Subsidy Based on Wireline Cost? – If HM Total wireline Monthly Cost Per Line is greater than the residential value in USF Subsidy Thresholds in ***HWM Inputs***, check if HM Total Wireline Monthly Cost Per Line is also greater than the business value in USF Subsidy Thresholds in ***HWM Inputs***. If it is, return "Res & Bus". If not, return "Res Only". Otherwise, return "None".
- Eligible for Subsidy Based on Wireless Cost? – If Wireless Model Total Monthly Cost Per Line is greater than the residential value in USF Subsidy Thresholds in ***HWM Inputs***, check if Wireless Model Total Monthly Cost Per Line is also greater than the business value in USF Subsidy Thresholds in ***HWM Inputs***. If it is, return "Res & Bus". If not, return "Res Only". Otherwise, return "None".
- Wireline Estimated Residential Subsidy Per Primary Line – If RESIDENTIAL LINE HM Total wireline CLLI monthly cost is greater than the residential value in USF Subsidy Thresholds in ***HWM Inputs***, return RESIDENTIAL LINE HM Total wireline CLLI monthly cost minus the residential value in USF Subsidy Thresholds in ***HWM Inputs***. Otherwise, return a zero.
- Wireline Estimated Total Residential Subsidy – Equal to Households multiplied by Wireline Estimated Residential Subsidy Per Primary Line.
- Single line business lines – Matches CLLI with wire center in ***HM Costs*** and returns the value in single line business lines from ***HM Costs***.
- Wireline Estimated Business Subsidy Per Line – If BUSINESS LINE HM Total wireline CLLI monthly cost is greater than the Business row value of USF Subsidy Thresholds in ***HWM Inputs***, check if single line business lines is greater than 0. If it is, return the value of BUSINESS LINE HM Total wireline CLLI monthly cost minus the Business row value of USF Subsidy Thresholds in ***HWM Inputs***. In any other case, return a zero.
- Wireline Estimated Total Business Subsidy – Equal to single line business lines multiplied by Wireline Estimated Business Subsidy Per Line.
- Wireline Estimated Total Subsidy – Equal to the sum of Wireline Estimated Total Business Subsidy plus Wireline Estimated Total Residential Subsidy.
- Wireless Estimated Residential Subsidy Per Primary Line – If HM Total wireline monthly cost per line is greater than the value of the Residential USF Subsidy Thresholds in ***HWM Inputs***, return the value of Wireless Model Total Monthly Cost Per Line minus the Residential USF Subsidy Thresholds. Otherwise, return a 0.
- Wireless Estimated Total Residential Subsidy – Equal to Households multiplied by Wireless Estimated Residential Subsidy Per Primary Line.
- Wireless Estimated Business Subsidy Per Line – If HM Total wireline monthly cost per line is greater than the Business row value of USF Subsidy Thresholds in ***HWM Inputs***, check if single line business lines is greater than 0. If it is, return the value of Wireless Model Total Monthly Cost Per Line minus the Business row value of USF Subsidy Thresholds in ***HWM Inputs***. In any other case, return a 0.

- Wireless Estimated Total Business Subsidy – Equal to single line business lines multiplied by Wireless Estimated Business Subsidy Per Line.
- Wireless Estimated Total Subsidy – Equal to Wireless Estimated Total Business Subsidy plus Wireless Estimated Total Residential Subsidy.
- Delta Wireless to Wireline Subsidy – Equal to Wireless Estimated Total subsidy minus Wireline Estimated Total Subsidy.
- Subsidized CLLI? (1=yes) – If Wireline Estimated Total Subsidy is greater than 0, return a one. Otherwise, return a zero.
- Wireless Subsidy Less Than Wireline (1 = yes) – If Wireless Estimated Total Subsidy minus Wireline Estimated Total Subsidy is less than 0, return a 1. Otherwise, return a 0.
- Percent Wireless Less Than Wireline – If Subsidized CLLI? (1 = yes) is 1, return the value of 1 minus (Wireless Estimated Total Subsidy divided by Wireline Estimated Total Subsidy. Otherwise, leave blank.
- Total ResBusPub Lines in Subsidized CLLIs – If Subsidized CLLI? (1 = yes) is equal to one, return CLLI ResBisPub Lines. Otherwise, return a 0.
- Subsidized CLLI Lines w/Wireless Advantage – If Percent Wireless Less Than Wireline is greater than 0, use Total ResBusPub Lines in Subsidized CLLIs. Otherwise, return a blank.
- Subsidized CLLI Lines w/Wireline Advantage – If Percent Wireless Less ThanWireline is less then 0, return the value of Total ResBusPub lines in Subsidized CLLIs. Otherwise, leave blank. .
- Subsidized CLLI Area w/Wireless Advantage – If Subsidized CLLI? (1 = yes) returns a 0, return a blank. If it returns a 1, check if Wireless Subsidy Less Than Wireline (1 = yes) is a 1. If it is, return the sum of Total HDC Area and Total Area Outside of HDCs. If not, return a 0.
- Subsidized CLLI Area w/Wireline Advantage – If Subsidized CLLI? (1 = yes) is 1, check if Wireless Subsidy Less than Wireline (1 = yes) is zero. If it is, return the sum of Average HDC Area and Average Non HDC Area. If it is not a zero, return a blank. If Subsidized CLLI? (1 = yes) was a 0, return a blank.
- Line Density w/Wireless Advantage (Lines/Sq.Mi) – If Wireless Subsidy Less Than Wireline (1 = yes) is 1, return the value of Subsidized CLLI Lines w/Wireless Advantage divided by the sum of Total HDC Area and Total Area Outside of HDCs. Otherwise, leave blank.
- Line Density w/Wireline Advantage – If Wireless Subsidy Less Than Wireline does not equal 0, return a blank. If it does equal 0, check if Percent Wireless Less Than Wireline is blank. If it is, return a blank. Otherwise, return the value of Subsidized CLLI Line w/Wireline Advantage divided by the sum of Total HDC Area and Total Area Outside of HDCs.

<u>Cell Radius Checks</u>

- Cell Site Proximity Flag (1 = Radius too small) – If Average Cell Area for Low Density Selection is 0, return a 0. Otherwise, check if Average Cell Area for Low Density Selection is less than Minimum Cell Coverage Area in ***HWM Inputs***. If it is less, return a 1. If not, check if Area per HDC Cell (Sq. Mi.) is equal to 0. If it is, return a zero. If not, check if Area per HDC Cell (Sq. Mi.) is less than Minimum Cell

Coverage Area in ***HWM Inputs***. If it is less, return a one. If it is greater or equal, return a zero.

- Radius Too Small On Subsidized CLLI (1 = yes) – If Select the Greater of Traffic or Coverage Cells plus Total HDC Cells is less than or equal to seven, return a 0. Otherwise, check Cell Site Proximity Flag (1 = Radius too Small). If it returned a 1, return the same value as Subsidized CLLI? (1 = yes). Otherwise, return a 0.
- Radius Too Small On Subsidized CLLI (1 = yes) – If Radius Too Small on Subsidized Wireless CLLI (1 = yes) returns a one, check Wireless Subsidy Less Than Wireline (1 = yes). If it returns a one, use 1, otherwise, use 0. If Radius Too Small on Subsidized Wireless CLLI (1 = yes) returns a zero, use 0.

Calculations for Summary Worksheet

- Eligible CLLI Estimated Monthly Wireless Cost – If Subsidized CLLI returns a one, use Wireless Model Total Monthly CLLI Cost. Otherwise, leave blank.
- Eligible CLLI Estimated Monthly Wireline Cost – If Subsidized CLLI returns a one, uses HM Total wireline CLLI monthly cost. Otherwise, leave blank.
- Wireless Advantage CLLI Wireless Monthly Subsidy – If Wireless Subsidy Less than Wireline shows a one, use the Wireless Estimated Total Subsidy. Otherwise, leave blank.
- Wireless Advantage CLLI Wireline Monthly Subsidy – If Wireless Subsidy Less than Wireline shows a one, uses Wireline Estimated Total Subsidy. Otherwise leave blank.
- Wireline Advantage CLLI Wireless Monthly Cost – If Wireless Subsidy Less than Wireline shows a zero, use the Wireless Estimated Total Subsidy. Otherwise, leave blank.
- Wireline Advantage CLLI Wireline Monthly Cost – If Wireless Subsidy Less than Wireline shows a zero, uses Wireline Estimated Total Subsidy. Otherwise leave blank.
- Wireless Lower Cost Wire Center, WL Cost, Per Month – If Wireless Model Total Monthly Cost Per Line is less than HM Total wireline monthly cost per line, use Wireless Model Total Monthly CLLI Cost. Otherwise leave blank.
- Wireless Lower Cost Wire Center, Wireline Cost Per Month – If Wireless Model Total Monthly Cost Per Line is less than HM Total wireline monthly cost per line, use HM Total wireline CLLI monthly cost. Otherwise, leave blank.
- Wireless Lower Cost Wire Center, Total Cluster Area (Sq.Mi) – If Wireless Model Total Monthly Cost Per Line is less than HM Total wireline monthly cost per line, use Total HDC Area plus Total Outside of HDCs. Otherwise, leave blank.
- Wireless Lower Cost Wire Center, Lines – If Wireless Model Total Monthly Cost Per Line is less than HM Total wireline monthly cost per line, use CLLI ResBisPub Lines. Otherwise, leave blank.
- Wireline Lower Cost Wire Center, WLess Cost, Per Month – If Wireless Model Total Monthly Cost Per Line is greater than HM Total Monthly Cost Per Line, use Wireless Model Total Monthly CLLI Cost. Otherwise, leave blank.
- Wireline Lower Cost Wire Center, Wireline Cost Per Month – If Wireless Model Total Monthly Cost Per Line is greater than HM Total Monthly Cost Per Line, use HM Total wireline CLLI monthly cost. Otherwise, leave blank.

- Wireline Lower Cost Wire Center, Total Cluster Area (Sq.Mi) – If Wireless Model Total Monthly Cost Per Line is greater than HM Total Monthly Cost Per Line, use Total HDC Area plus Total Area Outside of HDCs. Otherwise, leave blank.
- Wireline Lower Cost Wire Center, Lines – If Wireless Model Total Monthly Cost Per Line is greater than HM Total Monthly Cost Per Line, use CLLI ResBisPub Lines. Otherwise, leave blank.
- Tapered Monthly Subsidy – Selects the lower of the wireline or wireless subsidy. Used to calculate the lowest possible subsidy for a company or state using the more cost efficient technology for a particular wire center.

Summary Results

The HWM.xls template worksheet " ***Summary HWM Model Results*** " provides several pages of summarized data from the ***WC Data*** sheet. Included in the summarized information is the following (with occasional brief explanations italicized):

State Geographic and Demand Data - *General information in the model*

- Total LEC CLLIs (Wire Centers) In Model for State
- Total Service Clusters For State - *This includes all clusters, High Density and Low Density*
- Total Area In Clusters
- State Area – *Land and water area for the state*
- Total Radio Coverage Area Requirement – *The sum of radio coverage needed for each wire* center as calculated from the cluster data.
- Maximum Est(imated) Radio Coverage from Cells Generated by HWM – *Total square miles covered based on the number of cells calculated by the model and upper limit of square miles of coverage for each cell. Because there are a significant number of cells with overlapping coverage to handle densely populated areas, this figure will generally be much larger than the Coverage Area Requirement and State Area.*
- Total Residential, Single Business and Public Lines
- Percent of Access Lines Served – *As the current model is a total service model this is set at 100%*
- Average Line Density for all Service Clusters
- Estimated Total Cells Required to serve all Clusters

Investment Summary For The Entire State

- Total CLLI Site and Radio Equipment Investment
- Total Estimated Monthly CLLI Site and Radio Equipment Cost
- Cell Back Haul Investment
- Total Monthly Back Haul Cost for all Cells
- Total CIU Investment
- Total Monthly CIU Cost
- Total CLLI Site, RF Equipment, Microwave, Transcoder and CIU Investment
- Wireless Model Total Monthly CLLI Cost
- HM Total Wireline CLLI Monthly Cost

- Average Wireless Monthly Cost Per Line
- Average Wireline Monthly Cost Per Line

USF Subsidy Summary Results
- CLLIs Eligible for USF Subsidy
- ResBusPub Lines In Eligible CLLIs
- Eligible Lines as a Percent of Total Lines
- Wireless Model Total Monthly Eligible CLLI Cost
- HM Total Wireline Eligible CLLI Monthly Cost
- Wireless - Wireline Estimated Cost Delta
- Average Wireless Monthly Cost Per Eligible Line
- Average Wireline Monthly Cost Per Eligible Line
- Wireless - Wireline Average Eligible Line Cost Delta
- Estimated Total Wireless Monthly Subsidy
- Estimated Total Wireline Monthly Subsidy
- Wireless - Wireline Estimated Monthly Subsidy Delta

USF Subsidy Analysis
- Eligible CLLIs Where *Wireless* Is Less Expensive
- Eligible CLLIs Where *Wireline* Is Less Expensive
- Total Lines For *Wireless* Advantage CLLIs
- Total Lines For *Wireline* Advantage CLLIs Average
- Average Lines per *Wireless* Advantage CLLIs
- Average Lines per *Wireline* Advantage CLLIs
- Estimated *Wireless* Subsidy for Wireless Advantage CLLIs
- Estimated *Wireline* Subsidy for Wireless Advantage CLLIs
- Wireless - Wireline Estimated Subsidy Delta
- Estimated *Wireless* Subsidy for Wireline Advantage CLLIs
- Estimated *Wireline* Subsidy for Wireline Advantage CLLIs
- Wireless - Wireline Estimated Subsidy Delta
- Total Area For Eligible *Wireless* Advantage CLLIs
- Total Area For Eligible *Wireline* Advantage CLLIs
- Average Line Density - *Wireless* Advantage CLLIs
- Average Line Density - *Wireline* Advantage CLLIs
- Estimated "Tapered" Subsidy (Least Expensive Technology Subsidized) - *The model analyzes the subsidy requirements if the most cost-effective technology is selected for each wire center.*
- Total Estimated Wireline Monthly Subsidy
- Savings over Estimated Total Monthly Wireline Subsidy

Wireless vs. Wireline Costs - All Wire Centers
- CLLIs With A Wireline Cost Advantage
- Total Lines Served
- Total Cluster Area Served

- Total Wireline Monthly Cost
- Average Wireline Cost Per Line
- Total Wireless Monthly Cost *(In these wireline cost advantage CLLIs)*
- Average Wireless Cost Per Line *(In these wireline cost advantage CLLIs)*
- Wireline vs. Wireless Cost
- Cluster Line Density (Lines Per Square Mile)
- CLLIs With A Wireless Cost Advantage
- Total Lines Served
- Total Cluster Area Served
- Total Wireline Monthly Cost *(In these wireless cost advantage CLLIs)*
- Average Wireline Cost Per Line *(In these wireless cost advantage CLLIs)*
- Total Wireless Monthly Cost
- Average Wireless Cost Per Line
- Wireline vs. Wireless Cost
- Cluster Line Density (Lines Per Square Mile)

Cell Site Coverage Tests - *The model checks to see how many CLLIs may have calculated more cells than can be engineered into the actual area of the clusters.*

- CLLIs With Cells Potentially Too Close Together
- Subsidized CLLIs With Cells Potentially Too Close Together
- Wireless Advantage Subsidized CLLIs With Cells Potentially Too Close Together

Output for Custom Analysis With Mapping Software or Excel

The HWM.xls template also contains an unprotected worksheet, ***"Mapping Data"*** summarizing key data that can be exported to Mapinfo and integrated with Exchange Info by On Target Mapping. Data can be displayed visually to show the location of wire centers that have a wireless or wireline advantage, or the difference in costs, etc.

This worksheet can also be used to create "Pivot Tables". By using the Pivot Tables feature of Excel, data for individual companies and wire center can be analyzed. For instance, the following directions demonstrate how to create a Pivot Table in a results workbook that analyzes monthly subsidies by company.

Creating an Excel Pivot Table for Detailed Results Analysis

1. Select the ***Mapping Data*** workbook, and select Cell A1 within ***Mapping Data***.
2. From the Excel Main Menu pull down the Data sub-menu and click on "Pivot Table Report". The Pivot Table wizard should appear.
3. There is nothing that needs to be changed on the first page of the wizard so click Next.
4. The next page of the wizard asks to select the data you want to analyze, since the cursor was on cell A1, all columns and rows with data should already be defined in the wizard. There should be no need to modify that, so again just click Next.
5. The next page (3 of 4 in the heading) is where the Pivot Table is constructed. Note that all the column labels appear with truncated text to the right of the large white

area with areas labeled Row, Column and Data.

6. Using the mouse to move the cursor, let the cursor rest over one of the little boxes on the right. In a second or two the whole column label should be displayed. Find the box labeled "Company" in the first column. Click and hold on the box, and drag it over to the white area labeled "Row" and release the mouse button.
7. Move the cursor back over to the right and find the box labeled "CLLI" in the first column. Click and hold on the box, and drag it over to the white area labeled "Data" and release the mouse button. Note that a box is now showing the data area that says, "Count of CLLI", CLLI has alphanumeric data and Excel assumes you want to count that type of data.
8. Move the cursor back over to the right and find the box labeled "Wireline Estimated Total Subsidy" in the sixth column (slide the control bar below the little boxes to display all of them). Click and hold on the box, and drag it over to the white area labeled "Data" and release the mouse button. . Note that a box is now showing the data area that says "Sum of Wireline Estimated Total Subsidy", Wireline Estimated Total Subsidy has numeric data and Excel assumes you want to sum that type of data.
9. Move the cursor back over to the right and find the box labeled "Wireless Estimated Total Subsidy" in the seventh. Click and hold on the box, and drag it over to the white area labeled "Data" and release the mouse button.
10. Move the cursor back over to the right and find the box labeled "Tapered Monthly Subsidy" in the last column. Click and hold on the box, and drag it over to the white area labeled "Data" and release the mouse button.
11. At this point all the data to be analyzed has been identified, click Next.
12. The final page of the wizard asks if the data should be put in a new worksheet or the existing worksheet. Select the default (new worksheet) by just clicking Finish. This will create a new worksheet with the new pivot table. The sheet will be called "Sheetn", where n is a number, until renamed.
13. The first column of this worksheet will identify all companies in the results file for the selected state. The second column identifies the data summarized in the third column. There will be four rows for each company, the first row provides the number of CLLIs (wire centers) in the data for that company. The second totals the estimated wireline subsidy for that company as determined by HM (0 means no subsidy was calculated). The third row totals the estimated wireless subsidy for the same company as determined by HWM. And finally, the fourth row is the "Tapered" subsidy for that company. This is the subsidy calculated by selecting the lesser of the wireline or wireless estimated subsidy for each CLLI.
14. At the bottom of the pivot table you will find grand totals for all the data categories. In this case, these should match the statewide data in the ***Summary HWM Model Results*** sheet.
15. Once created, to change the formatting or data analyzed for the pivot table select any cell in the pivot table and then pull down the Data sub-menu and click on "Pivot Table Report". This will return you to the third page of the pivot table wizard, at this point you can add or delete data fields, rows or columns – or, by clicking on the boxes once they have been dragged over, change formatting and other features.

CERTIFICATE OF SERVICE

I, Cecelia Burnett, hereby certify that on this 26th day of January, 1999, copies of the Ex Parte of Western Wireless Corporation on the Joint Board on Universal Service, CC Docket No. 95-445, were served on the parties listed below by hand delivery or first class mail.

Cecelia Burnett

The Honorable William E. Kennard
Chairman
Federal Communications Commission
445 Twelfth Street, S.W.
Washington, D.C. 20554

The Honorable Susan Ness,
Commissioner
Federal Communications Commission
445 Twelfth Street, S.W.
Washington, D.C. 20554

The Honorable Harold Furchgott-Roth
Commissioner
Federal Communications Commission
445 Twelfth Street, S.W.
Washington, D.C. 20554

The Honorable Michael K. Powell
Commissioner
Federal Communications Commission
445 Twelfth Street, S.W.
Washington, D.C. 20554

The Honorable Gloria Tristani
Commissioner
Federal Communications Commission
445 Twelfth Street, S.W.
Washington, D.C. 20554

Thomas Power
Legal Advisor
Office of Chairman Kennard
Federal Communications Commission
445 Twelfth Street, S.W.
Washington, D.C. 20554

Ari Fitzgerald
Legal Advisor
Office of Chairman Kennard
Federal Communications Commission
445 Twelfth Street, S.W.
Washington, D.C. 20554

Linda Kinney
Legal Advisor
Office of Commissioner Ness
Federal Communications Commission
445 Twelfth Street, S.W.
Washington, D.C. 20554

Dan Connors
Legal Advisor
Office of Commissioner Ness
Federal Communications Commission
445 Twelfth Street, S.W.
Washington, D.C. 20554

Paul Misener
Senior Legal Advisor
Office of Commissioner Furchtgott-Roth
Federal Communications Commission
445 Twelfth Street, S.W.
Washington, D.C. 20554

Kevin Martin
Legal Advisor
Office of Commissioner Furchtgott-Roth
Federal Communications Commission
445 Twelfth Street, S.W.
Washington, D.C. 20554

Kyle D. Dixon
Legal Advisor
Office of Commissioner Powell
Federal Communications Commission
445 Twelfth Street, S.W.
Washington, D.C. 20554

Peter Tenhula
Legal Advisor
Office of Commissioner Powell
Federal Communications Commission
445 Twelfth Street, S.W.
Washington, D.C. 20554

Paul Gallant
Legal Advisor
Office of Commissioner Tristani
Federal Communications Commission
445 Twelfth Street, S.W.
Washington, D.C. 20554

Karen Gulick
Legal Advisor
Office of Commissioner Tristani
Federal Communications Commission
445 Twelfth Street, S.W.
Washington, D.C. 20554

Lawrence Strickling
Bureau Chief
Common Carrier Bureau
Federal Communications Commission
1919 M Street, N.W., Room 500
Washington, D.C. 20554

Richard Cameron
Legal Assistant to the Bureau Chief
Common Carrier Bureau
Federal Communications Commission
1919 M Street, N.W., Room 500
Washington, D.C. 20554

Irene Flannery, Chief
Accounting Policy Division
Common Carrier Bureau
Federal Communications Commission
2100 M Street, N.W., 8th Floor
Washington, D.C. 20554

Craig Brown
Deputy Chief
Accounting Policy Division
Common Carrier Bureau
Federal Communications Commission
2100 M Street, N.W., 8th Floor
Washington, D.C. 20554

Emily Hoffnar
Associate Chief
Accounting Policy Division
Common Carrier Bureau
Federal Communications Commission
2100 M Street, N.W., 8th Floor
Washington, D.C. 20554

Chuck Keller
Accounting Policy Division
Common Carrier Bureau
Federal Communications Commission
2100 M Street, N.W., 8th Floor
Washington, D.C. 20554

Jeff Prisbrey
Accounting Policy Division
Common Carrier Bureau
Federal Communications Commission
2100 M Street, N.W., 8th Floor
Washington, D.C. 20554

William Sharkey
Accounting Policy Division
Common Carrier Bureau
Federal Communications Commission
2100 M Street, N.W., 8th Floor
Washington, D.C. 20554

Richard Smith
Accounting Policy Division
Common Carrier Bureau
Federal Communications Commission
2100 M Street, N.W., 8th Floor
Washington, D.C. 20554

Jane Whang
Accounting Policy Division
Common Carrier Bureau
Federal Communications Commission
2100 M Street, N.W., 8th Floor
Washington, D.C. 20554

Sheryl Todd
Accounting Policy Division
Common Carrier Bureau
Federal Communications Commission
2100 M Street, N.W., Room 8611
Washington, D.C. 20554

C. Anthony Bush
Office of General Counsel
Federal Communications Commission
1919 M Street, N.W., Room 500
Washington, D.C. 20554

Thomas Sugrue
Chief
Wireless Telecommunications Bureau
Federal Communications Commission
2025 M Street, N.W., Room 5002
Washington, D.C. 20554

Jim Schlichting
Deputy Chief
Wireless Telecommunications Bureau
Federal Communications Commission
2025 M Street, N.W., Room 5002
Washington, D.C. 20554

Jeanine Poltronieri
Senior Counsel
Wireless Telecommunications Bureau
Federal Communications Commission
2025 M Street, N.W., Room 5002
Washington, D.C. 20554

Steven Weingarten
Chief
Commercial Wireless Division
Wireless Telecommunications Bureau
Federal Communications Commission
2100 M Street, N.W., 7th Floor
Washington, D.C. 20554